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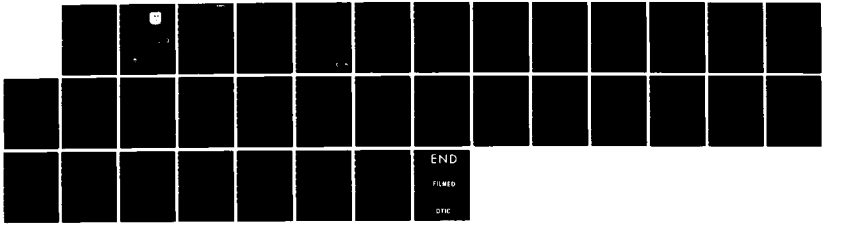

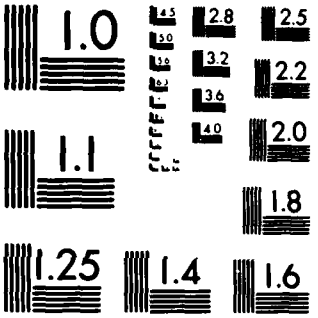

STUDENT ESSAY

THE EVOLUTION FROM DATA PROCESSING TO INFORMATION RESOURCE MANAGEMENT

BY

COMMANDER STEPHEN P. PLUSCH, USCG

16 MAY 1984

US ARMY WAR COLLEGE, CARLISLE BARRACKS, PENNSYLVANIA

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With the tremendous growth in the capability, complexity, pervasiveness, and cost of information systems in recent years, corporate America has realized that information is a vital corporate asset (resource) and must be managed as such. Congress has mandated that Federal agencies improve their ability to manage information through the Brooks Act of 1965 and the Paperwork Reduction Act of 1980 (also sponsored by Congressman Brooks). The process of gaining control of an organization's information has been called Information Resource Management (IRM). This paper is a survey of the essential elements of IRM focusing on

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USAWC MILITARY STUDIES PROGRAM PAPER

THE EVOLUTION FROM DATA PROCESSING TO INFORMATION RESOURCE MANAGEMENT

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ABSTRACT

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"The organizations that will excel in the 1980's will be those that manage information as a resource."[1]

With the tremendous growth in the capability, complexity, pervasiveness, and cost of information systems in recent years, corporate America has realized that information is a vital corporate asset (resource) and must be managed as such. Congress has mandated that Federal agencies improve their ability to manage information through the Brooks Act of 1965 and the Paperwork Reduction Act of 1980 (also sponsored by Congressman Brooks). The process of gaining control of an organization's information has been called Information Resource Management (IRM). This paper is a survey of the essential elements of IRM focusing on methods that are used to develop an Information Systems Architecture (ISA). This is particularly timely since HQDA recently completed a Information System's Planning (ISP) exercise, and created a new Deputy Chief of Staff for Information Management (DCSIM). A summary of the important findings of this study are presented. The late Bernard Shaw once wrote, "To be in Hell is to drift, to be in Heaven is to steer." This paper attempts to survey the course for planning the near and long-term information needs of large organizations including the U.S. Army.

THE EVOLUTION FROM DATA PROCESSING TO INFORMATION RESOURCE MANAGEMENT

HISTORY

Since early times, people have looked for more efficient ways to obtain and process data and information. We generally distinguish between data and information in the following way: 1) data is raw material gathered from one or more sources, 2) information is processed or 'finished data.' The U.S. Census Bureau used one of the first large data processing systems. Herman Hollerith developed a mechanical method to tabulate massive amounts of population data on punched cards. Herman Hollerith's company eventually became IBM in 1924. After World War II, the use of computers increased rapidly. The Census Bureau installed the first commercially available computer, the UNIVAC I, in 1951. The first business use of a computer was by General Electric in 1954. These computers were use to automate burdensome clerical chores that hampered growing companies during this time period.

Because the cost per arithmetic operation of these early computers was smaller for large machines and handling of data and programs on magnetic tape or with punched cards was time-consuming and complex, data was processed in 'batch' style in large centralized facilities. During ordinary operations, hours and sometimes even days might elapse between

processing of these batches. Only the data processing 'experts' were allowed in these facilities and they became the 'high priests' of the data processing departments. Magnetic disk, direct access, storage devices dramatically increased the ease with which data could be processed and stored.

In the late 1950s, the development of transistors began to revolutionize the computer industry. The speed and power of computers increased dramatically while their size began to shrink; these solid-state machines were called second-generation computers. The relative impact of the transistor on computer technology is illustrated with the following example:

> ...Compared to the cost of a quality transistor 20 years ago--about $1 to $10--the equivalent cost of a transistor in a chip today is something like one hundredth of a cent--a thousand-fold cheaper.
>
> If we had the same progress in the aircraft industry, you and I could be flying between London and New York in 500,000-passenger planes, and the fare would be only about 25 cents. [2]

Third generation computers, using micro-chips (containing hundreds of transistors and today hundreds of thousands of transistors), were installed during the mid-sixties. From the third generation, came systems known as 'minicomputers'; these relatively low-cost, high performance machines began to appear outside the computer center. Minicomputers allowed end users to have their own machines to do specialized tasks.

These computers, and to an even greater extent, the

new micro-computers (based on a micro-chip containing all the elements of a computer's central processing unit), having tremendous processing power and the ability to be installed on an office desk, require new methods of managing computer hardware, software, and communications equipment. These dispersed operations hint at large networks of distributed computers (mainframes to desk-top) connected and working together.

With the tremendous improvements in the capability of new software, end users can now have access to the large computer in the data center in an interactive mode via terminals or desk-top computers. The increased demand generated by these new users is causing great stress on data processing departments. As corporate executives become aware of the power of the new machines, they will want answers to diverse questions requiring data from numerous sources. Unless corporate data is organized properly, it will be inaccessible to even the most powerful computers. Today's executive is not willing to send a question to the data processing department and wait several hours or days for the answer which comes buried in reams of computer printout. We are being challenged to provide the capability for the executive to ask his question of the computer, in English, and to receive a response in less than one second; this is the promise of the Information Revolution. However, if an organization's information is

not carefully organized, there will be "distributed chaos". Many times it is obvious to a company's analysts that the answer to an executive's question is in their corporate data, but it cannot be extracted without an inordinate amount of difficulty. Because in the information systems planning discipline the basic techniques used to accomplish it are relatively insensitive to an organization's size and purpose, the words company, corporation, organization, military service, and business will be used interchangeably.

During the Nineteenth Century, we had the Industrial Revolution; we are now in the midst of the Information Revolution. Computers, their programs, and their data have become such vital and costly assets of businesses and organizations that they can no longer be managed in isolation. They must now be considered a corporate resource and managed as such. The technique being espoused as necessary to effectively manage the tremendous volume of information within all types of organizations is called Information Resource Management (IRM). There are several important aspects to Information Resource Management: 1) it must be carried out in consonance with the overall goals and objectives of the organization, 2) the type of data necessary to support the activities of the organization must be known, 3) the data must be organized to permit efficient and timely retrieval, and 4) the data must be presented to

the end user in a form which is understandable and immediately useful (ideally, the end user should be able to access information in the computer in English and be able to easily format the output in a way which is immediately useful to him i.e. charts, graphs, or text as appropriate).

TRANSACTION PROCESSING VERSUS INFORMATION PROCESSING

Traditionally, computers have been used to relieve clerks of their paperwork burden. The primary responsibility of the data processing department was to reduce the clerical costs of producing larger and larger volumes of paper output. It created and operated transaction oriented systems to carry on the operational business of the corporation. The importance of transaction processing cannot be underestimated; these systems are the central nervous system, excluding the brain, of large corporations. These systems process orders, control the inventory, pay the employees and vendors among other tasks. These systems have improved the productivity of the clerical workers of corporations immensely. The greatest problem, however, is that the information generated in these operational systems is rarely, if ever, available to corportate management in a meaningful form. In general, the corporate executive is not willing to wade through piles of paper generated by

the operational systems to glean the important management information that he is seeking. This task is turned over to a staff of corporate analysts who try to determine what the executive is seeking and then search the corporate data (many times manually) to produce the answers. Dr. John Rockart of MIT has called this, "...the paper-processing tail wagging the information dog."[3] The challenge today is to develop a strategy to integrate the information from these functionally oriented operational systems in a form that can make 'management information' available to the corporate executive.

The first step in this process is for top management to determine what they want the organization to be and how they want to get it there. In the case of the U.S. Army, the Total Army Goals articulated by the Secretary of the Army and the Chief of Staff provide this direction. These goals are designed to provide the focus for achievement of common ends and provide guidance to the Total Army. It has always been the case that corporate objectives are fundamental to the proper management of an organization. These objectives are especially important in Information Resource Management because they help determine the future. With these objectives in mind, management establishes strategies and activities (procedures) to achieve them. Measurement information is necessary to provide feedback to

management as to the degree to which they are achieving the stated objectives. According to Peter Drucker:

> From the definition of its mission and purpose a business must arrive at objectives in a number of key areas; it must balance these objectives against each other and against the competing demands of today and tomorrow. It needs to convert objectives into concrete strategies and to concentrate resources on them. Finally it needs to think through its strategic planning, i.e. the decisions of today will make the business of tomorrow.[4]

INFORMATION RESOURCE MANAGEMENT

Information resource management is the integration of diverse disciplines, technologies, and data bases, and other information handling resources. There are three primary areas of concern in IRM: planning, people, and technology. The task of information Resource Management includes the following:

1. Integrating the functions of data processing, administrative processing, and office automation.

2. Subjecting all information systems overhead activities to the analysis techniques normally applied to direct labor.

3. Subjecting office automation programs to analyses used for the acquisition of any other capital asset.

4. Conceiving organizational designs that will permit information to be handled as a readily accessible and easily priced commodity rather than as a bureaucratic possession.

5. Creating within the organization an internal market for alternative information systems products, so that trade-off decisions can be decentralized into the hands of local user management.

6. Fostering a technique of pricing that will allow decisions on introducing new technology, or abandoning

obsolete technology, to be made on a decentralized basis.

7. Installing and monitoring measurement methods that will protect improvements in productivity achieved by automation programs.[5]

The evolution of these tasks was best portrayed by Nolan when he described six stages of EDP (electronic data processing) growth as shown in Figure 1.[6] It appears that the Army is in the later portion of Stage 2 and moving into the initial phases of Stage 3.

The type Class III data base referred to in the figure 1 is an integrated data base which serves numerous applications; methods to obtain such data bases will be discussed.

There are a number of strategies to put together an appropriate management structure and a plan to make effective use of an organization's information. The first formal and most widely used method was developed by IBM and is called Business Systems Planning (BSP); this is known as a total study method in which the information needs of an organization are studied in fine detail. There are a number of variations of this process. Holland Systems has developed a process called Strategic Systems Planning; in this method special software is available to assist in the planning process. A comprehensive methodology called Information Engineering is described by Clive Finkelstein and James Martin. Finkelstein's company sells a methodology called Infomethod.

Each of these methodologies have several basic phases:

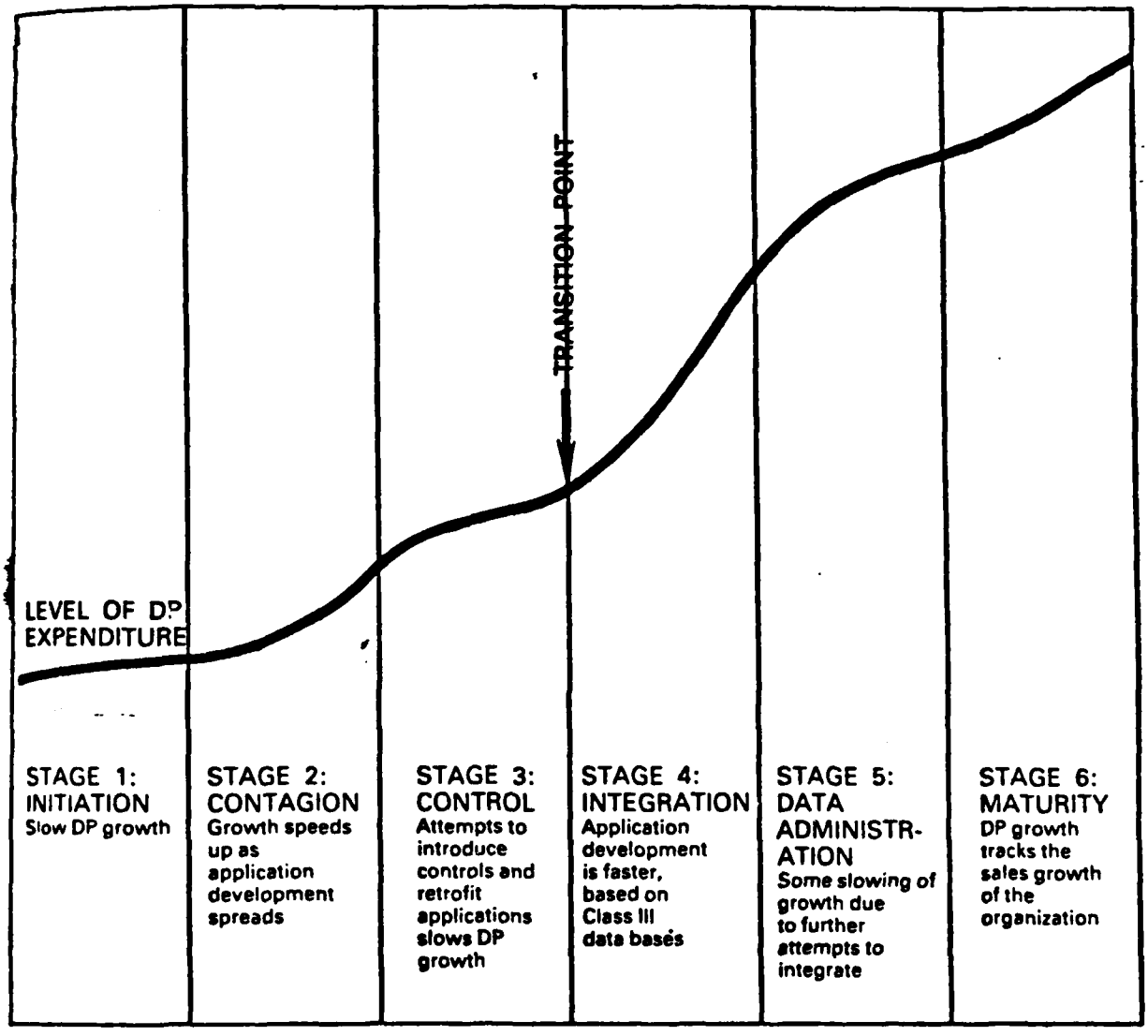

Figure 1. Nolan's Six Stages of Data Processing Growth

1. Strategic requirements planning - a top-down analysis of the organization which answers the question "What is the nature of the enterprise or the business that the information systems must support?" (A business system plan)

2. Information Analysis - an identification of the data used to support the business which answers the question "What data do I need in the information system?" (User views, Logical Information Model)

3. Procedure Formation - an identification of how present information systems meet the needs of the organization and what additional systems are needed. (Event Diagrams, Structured English Procedures)

4. Implementation - realization of the improved information system in modular form (with appropriate priority assigned to each module). (Physical Database Design, Successive Series of Prototypes)

In some methodologies, the terms for these phases and the detail to which they are accomplished may differ, but they are all essential parts of the data planning process. These phases do not have to occur strictly in this sequence. They are iterative in nature with each phase building upon the previous one and refining it.

There are two extremely critical factors in developing and executing the information system planning process. These are (1) the necessity for unqualified top-management support, and (2) continuous involvement of the end user.

Historically, "efficiency" has been the watchword for ADP operations. The machines and their peripherals were so expensive to acquire and run that it was important for them to be run as efficiently as possible. While efficiency is still very important, particularly for transaction (operationally) oriented systems, "effectiveness" is far more important in

information systems for top-management. Also, Historically, functional autonomy has been the rule. This has resulted in fractionalized and redundant data files and in the inaccessibility of data from the many operational applications installed within the various functions of the organization.

The IRM methodologies are top-management driven. The top is the natural vantage point of the managers who will use the information systems. Therefore, they have a vested interest in seeing that they are designed to meet their needs. Because IBM's methodology was used within the Army Staff, the steps entailed in its application are reviewed below.

INFORMATION SYSTEMS PLANNING (IBM STYLE)

The BSP effort is a combination of top-down and bottom up approaches as are the other methodologies discussed previously. This top-down/bottom-up approach is illustrated in Figure 2.[7] The study is accomplished by a highly qualified team of individuals intimately familiar with the business and ADP professionals. The BSP effort studies the organization from the very broad world in which it exists down to the data required to run its operational segment. In this effort, the organizational objectives are developed and the various organizational functions are identified. These organizational objectives are at the strategic level. Strategic planning is a process for exercising favorable influence over future

TOP DOWN ANALYSIS/BOTTOMS UP IMPLEMENTATION

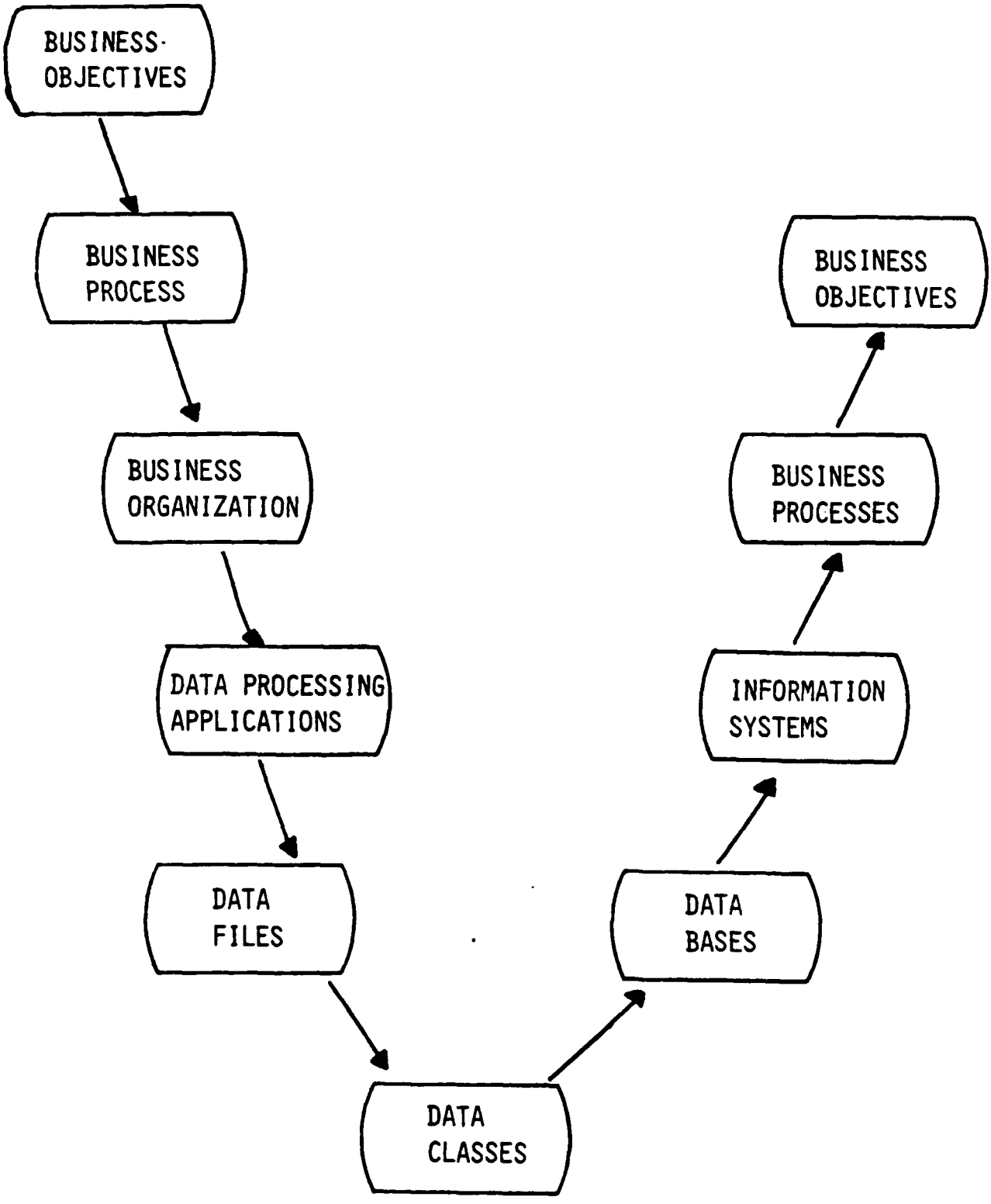

Figure 2. IBM's Business Systems Planning Methodology

events. It is performed at a high level within the organization. Also, strategic planning is active rather than passive like forecasting or budgeting which estimate the future rather than influence it. Strategic planning is necessary to guide all other planning activities.

The major activities and decision processes are then identified. These processes, referred to as business processes, are those groups of logically related decisions and activities required to manage the resources of the business. Once these activities and processes have been validated by top-management, then the data required to support them is identified and aggregated into data classes. A data class is a set of information such as customer information.

An examination of coverage of the existing information systems is conducted. The necessary information systems are then compared to the existing ones and a plan to develop new (modular) systems to fill the gap is generated. In this phase, an information architecture is developed with the modular systems as the building blocks. Priorities are established for the development and implementation of the systems. The progress in implementing these systems is measured against the plan and evaluated to insure that they are in consonance with the organization's overall strategic plan.

Throughout the development of the BSP, there are interviews with top-management personnel. These interviews

are critical to the success of the study. A methodology for gaining the critical management perspectives in these interviews by employing the "Critical Success Factor" technique is discussed in a subsequent section.

The overall objectives of the Information Systems Plan are as follows:

1. Establishes information systems priorities

2. Provides for the development of systems which will have a long life.

3. Insures that data processing resources are applied in support of organizational goals.

4. Produces systems that are responsive to user requirements and priorities.

5. Identifies data as a corporate resource.[8]

A list of the advantages to management of conducting a BSP study, defining an information systems architecture, and developing an information systems plan is as follows:

1. Top management is involved and communication with the management information systems professionals is enhanced.

2. It allows management to evaluate the effectiveness of existing information systems.

3. It allows management to assess future information needs based upon organization impact and priorities.

4. It provides early return on the organization's information systems investment.

5. It provides for consistent data to be available to and shared by all users.

6. It produces systems that are management/user oriented rather than DP oriented.

7. It provides a long-range planning base for DP resources and funding.9

In the end, the BSP process provides for the development of non-redundant data bases usable by one or more applications. The implication here is that corporate effectiveness will increase through information sharing across functional lines. IBM considers architecture the key link between strategy and planning. Strategic information systems planning insures that the organization will be in a position to take advantage of emerging hardware and software technology to satisfy requirements throughout the planning horizon. It must be directly tied to the future business directions of the organization.

CRITICAL SUCCESS FACTORS

> Critical success factors are the few key areas of activity in which favorable results are absolutely necessary for a particular manager to reach his goals.[10]

The CSF interview is a structured technique whose purpose is to allow an interviewer to assist managers in determining their critical success factors. This is an iterative process consisting of approximately three interviews. In the first interview, the executive's goals are recorded and the CSFs related to the accomplishment of the goals are discussed. The interrelationships of the CSFs are discussed and they are refined, combined, or eliminated. An initial set of measures corresponding to the CSFs is also discussed briefly.

The results of the first interview are reviewed in the

second. During the period between the interviews, the analyst has determined some ways to "sharpen up" some of the CSFs. In the second session, the measures and possible reports are discussed in detail. A third interview may be required before agreement on the final CSFs is reached.

For any business, the critical success factors are a limited number of areas in which, if they are satisfactory, will insure that the business will compete successfully. If the business is to flourish, things must go right in these areas. Therefore, the critical success factors are areas of activity that should receive careful and continuous attention from the manager. The goal of the information system is to provide timely data so that the performance in these areas can be measured continually.

One difficulty with the CSF technique is that you have to be aware that the manager, particularly a busy one, will put extra emphasis on "the problem of the moment." Some factors critical to his long-term success could be overlooked in this way.

THE DATA BASE ENVIRONMENT

In order to achieve the integration of information systems and to allow the sharing of data from these systems across functional boundaries within a corporation, database management systems are required.

> A data base is a shared collection of interrelated data designed to meet the needs of multiple types of end users. It can be defined as a collection of data from which multiple different end user views can be derived. The data are stored so that they are independent of the programs which use them. Adding new data and modifying and retrieving existing data is carefully controlled. Retrieving data may be carried out by multiple users in different ways with appropriate controls. The data are structured so as to provide a foundation for future application development.11

The goal of the strategic data planning process is to obtain stable data bases. The data bases that have been developed in the traditional bottom-up form are not stable; these data bases must be changed when the applications change. This is a very time-consuming and expensive process. Some companies have found that up to eighty per cent of their data processing resources are tied up in the maintenance of data bases and applications programs. It is this problem which strategic data planning seeks to minimize.

From the business processes delineated in the BSP process, a list of activities and entities (data classes) is developed. These entities are grouped together to form subject data bases. The entities are grouped so they fit together on a subject basis. The manner in which a company does things may change, but as long as it's in the same fundamental business, the types of data will not change. The information a company needs to operate on is divided up into a small number of these subject (class III) data bases.

The identification of subject data bases from the strategic data model provides a quick top-down blueprint of

the data groups needed to support the business activities of a company. Using a combination of the top-down and the bottom-up approaches, stable data bases which require little maintenance can be developed.

The relationships of the data to the application program are shown for a conventional file-based system in Figure 3. Notice how intimately the data is tied to the program. If any program or data file is changed, several of the other programs or data files must be changed also.

The use of a data base management system to isolate the end user from the data is shown in Figure 4. The maintenance required, should it be necessary to change a data base or an applications program, is minimized. In Figure 5., the ideal situation is shown. The end user can communicate with the data with an english-like query language. In this way, the end user can obtain the data without writing programs. He can format the output as desired using a report generator. More information can be obtained from James Martin's books on data base and application development without programmers.[12,13]

IRM IN THE FEDERAL GOVERNMENT

There are several special factors which make IRM in the Federal Government critically important. Congressman Jack Brooks (D., Texas) has sponsored several pieces of legislation which impact Government Automatic Data Processing (ADP).

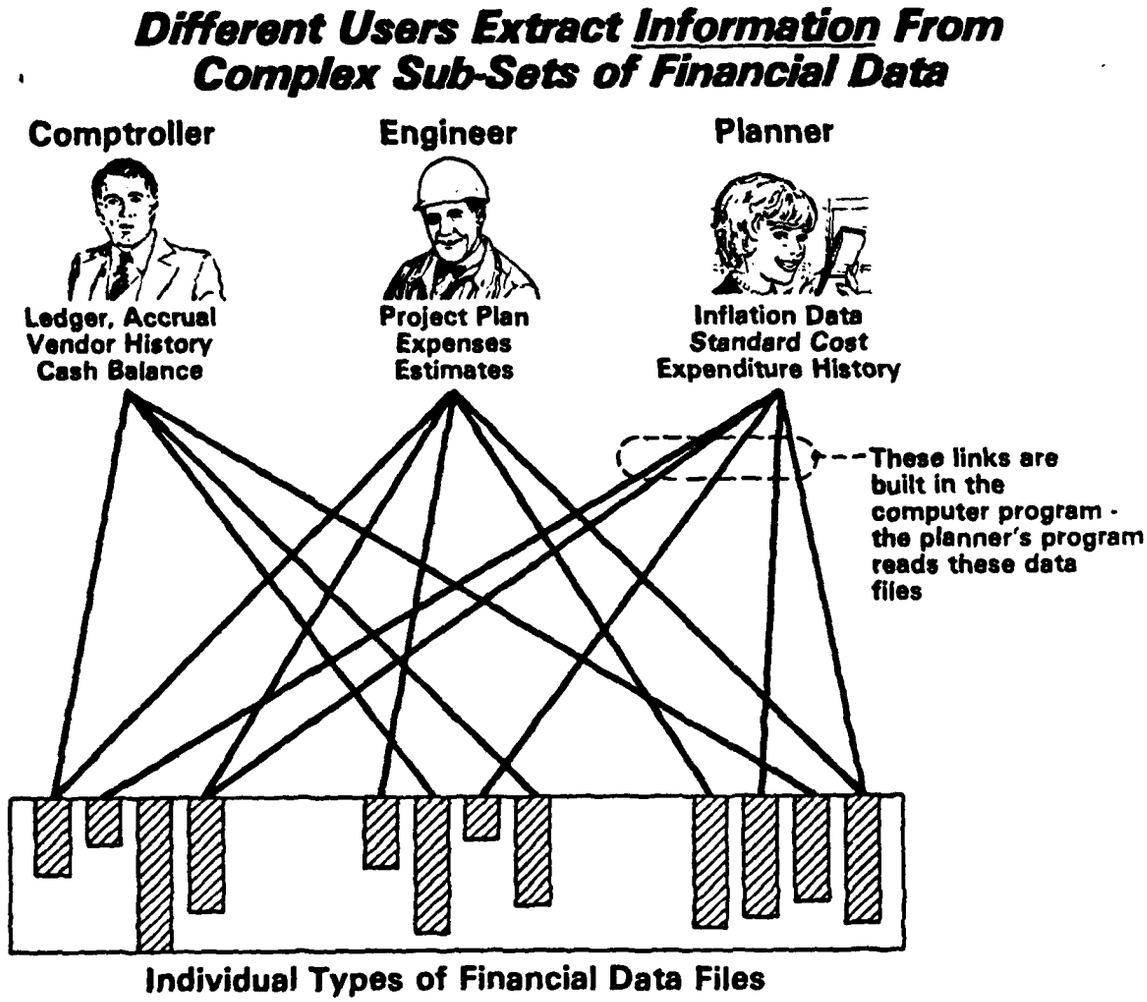

Figure 3. File Based Data System

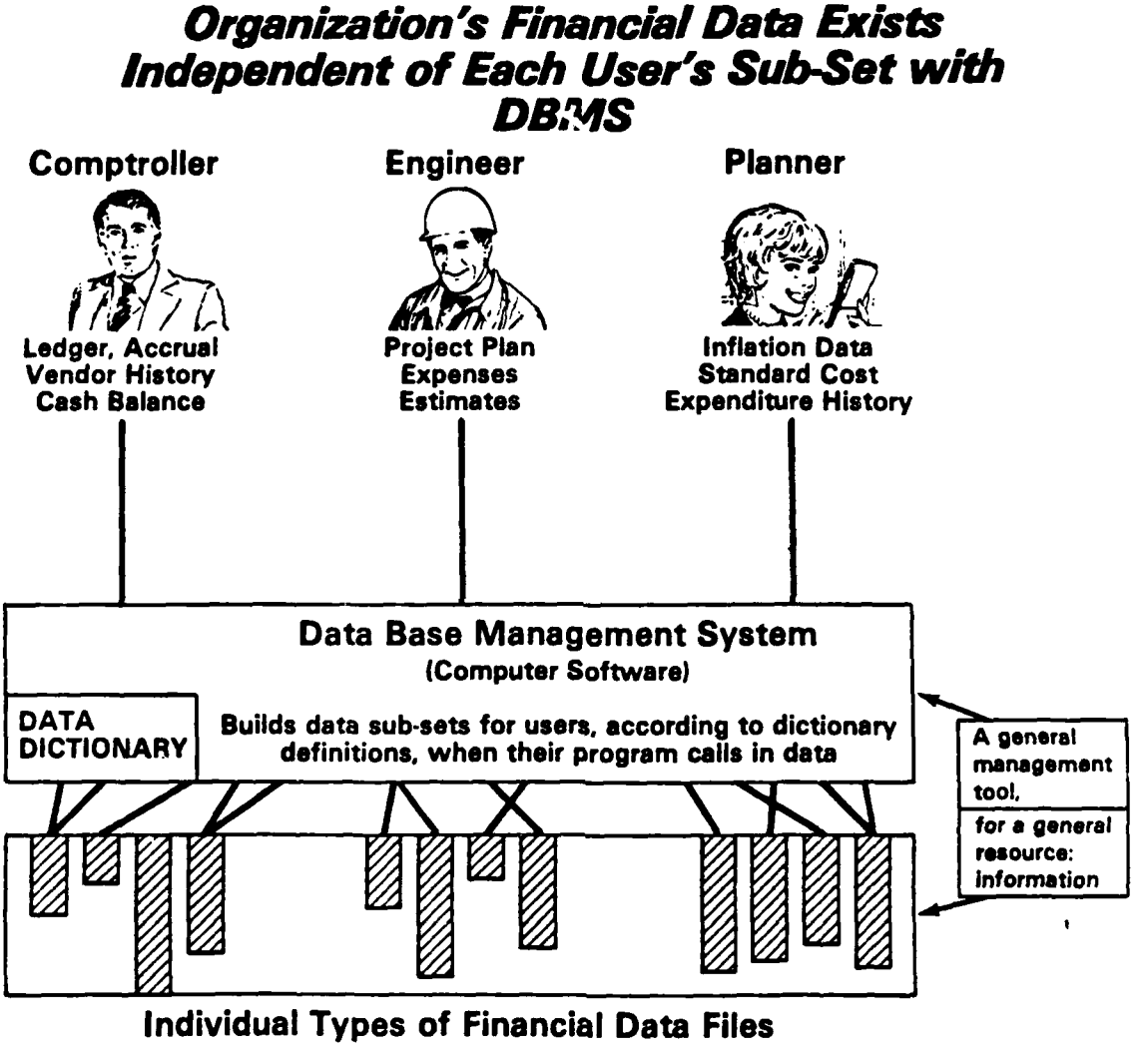

Figure 4. Data Base Management System.

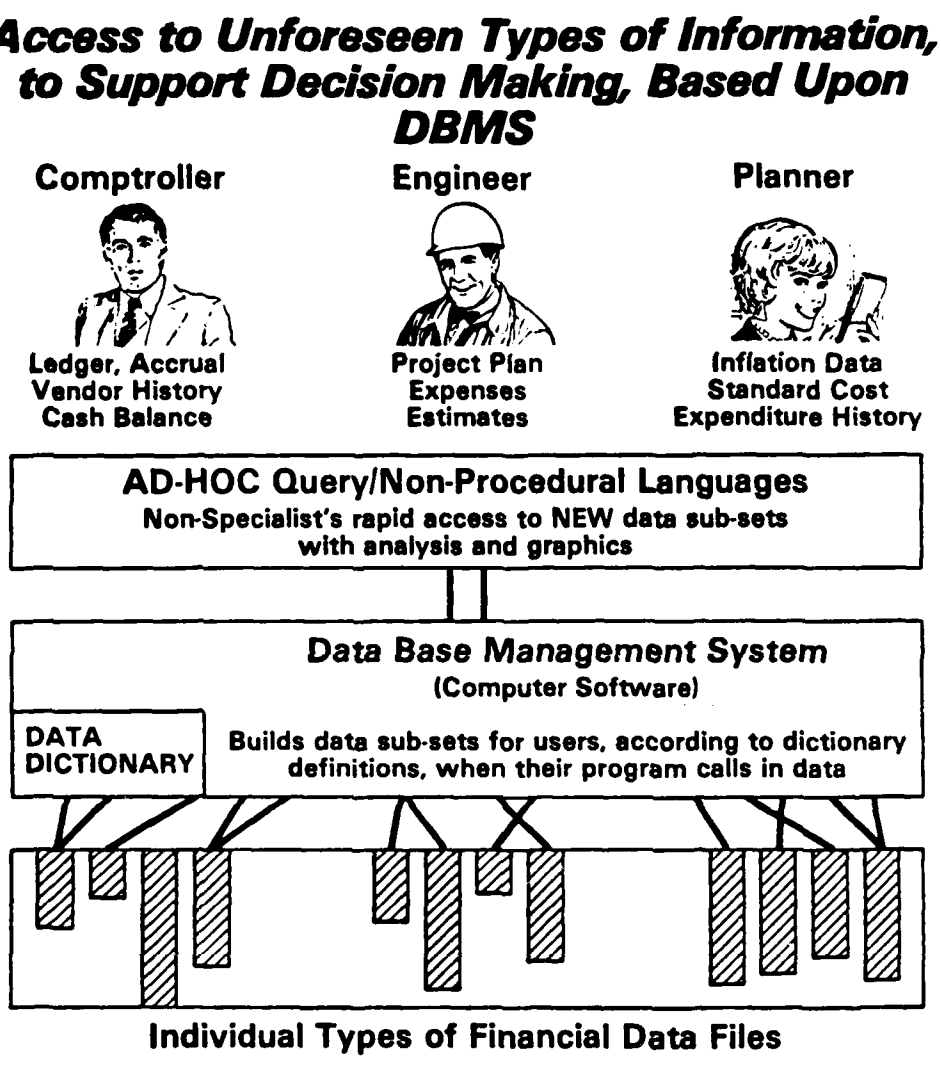

Figure 5. Data Base Management System With English Query.

The Brooks Act of 1965 was intended to provide overall policy guidance for the management of information systems within the Federal Government. It gave three agencies--OMB, GSA, and NBS--significant authority over Government-wide computer activities: 1) OMB, which exercises an overall policy role, 2) GSA, which has cognizance over procurement matters, and 3) NBS, which is charged with developing Federal Information Processing Standards (FIPS).

The Paperwork Reduction Act of 1980, also sponsored by Congressman Brooks, had even more significance. This bill originated in the House, Government Operations Committee and had laudable intent. It was an effort to control government paperwork. Its aim was to reduce the reporting demands levied by the Government on individuals and businesses. The bill called for the creation of a "Senior Official" in each agency, responsible to the agency head, concerned not only with paperwork, but with "information management" including computer processing. The Warner Amendment on the DOD FY82 Authorization Act provided some relief. This amendment excluded ADP for certain defense, intelligence, investigatory, and clearly "embedded" (such as the computer in an aircraft's navigation system) applications. DOD is under heavy pressure to abide by the act for the acquisition and operation of general purpose ADP systems. With the increasing oversight and budget micro-management by Congress, it is very important to develop a strategy to manage information efficiently within

DOD and the Army. The creation of the new DCSIM, within HQDA, provides a focal point for information management.

The Army, and it is not alone, does not have an institutional mechanism for providing positive direction and control of information. In a 1980 Arthur Young Study and during the resent Information Systems Planning (ISP) process, a number of IRM problems were identified:

1. There is no overall information plan or information systems architecture.

2. Information sharing is inadequate.

3. There is insufficient awareness of information availability.

4. There is widespread information redundancy.

5. Data base standardization is inadequate.

6. There is insufficient flexibility for systems to respond to change.

7. There is a need to allocate and prioritize information resources.

8. There is a need for effective program review of the use of information resources.14

These problems are common to organizations in the latter stages of Stage 2. There are any number of vertical, "stove pipe", functionally oriented information systems in the Army. The performance of some of the systems are outstanding, but some suffer performance problems. The most significant shortcoming is the lack of horizontal information flow among them which leads to data redundancy, the lack of temporal consistency, and the inability to extract and relate important

management information.

With the new IM organization in place, the Information Systems Plan done for HQDA, and continued top-management support, the Army should be on its way to effective Information Resource Management

A FINAL PERSPECTIVE

Richard Nolan, who developed the six stages of data processing growth, formed a corporation, The Nolan-Norton Corporation, to study the manner in which various corporations manage their information. Their basic approach to getting a handle on corporate information is to look at the corporation's applications portfolio as a capital asset. This gives the portfolio its proper perspective, namely that it contributes to the corporation's wealth and production, it has a limited life-span, and it must be maintained, depreciated, and eventually written off.

The traditional manner of thinking of DP systems is more like the way we think of our financial assets. We focus on the up-front costs and acquisition problems and neglect the maintenance/replacement aspects so central to capital asset management. Ten to fifteen years ago, data processing managers felt that if you built a good system to tightly specified requirements that it would be good for the duration. They failed to realize that, built well or poorly, information systems are part of a living and dynamic business environment

which is constantly changing; therefore, the systems must change to retain their utility. In keeping these systems current, maintenance/replacement becomes the dominant consumer of all of the DP resources. The planning process must account for this aspect of our information systems. Nolan-Norton has developed metrics with which to determine the value and the health of an organization's applications portfolio.

It is apparent; therefore, that proper strategic data and information system planning is vital to the health of an organization.[15]

FAILURES OF IRM EFFORTS

Real organizations are much more complex than any textbook examples. Many early attempts to build stable, integrated data bases to be shared across many functions failed. These failures occurred for several reasons:

1. The magnitude of the task was underestimated.
2. Appropriate design methodologies were not used.
3. Organizational politics prevailed, partly because of a lack of strong management with a clear perception of what was to be accomplished.
4. There was no overall architect who could design the data models necessary.
5. Sufficient automated tools were not available to insure that the planning data base could be updated easily.

The Information Management organization must guard against these evils if they are to succeed.

A bit of history is in order to provide some insight on the problems to be faced on the information management path. In the "office of the past" four largely independent specialized groups were involved in user organizations. They were the data processing group, the specialized office products (mailing equipment and duplicators) group, the general office products group (typewriters and copiers), and the telecommunications product group (telephones and switchboards). Typically, corporate authority for each of these groups was vested in a different person. The new office environment involves the use of networks to interconnect many of these types of products. Each area has a parochial view and this is partly to blame for problems in implementing integrated systems.

In formulating the information system policies of the 1980's, managers must deal with two main conflicts: 1) the tension between innovation and control, and 2) the conflict between the Information Management group and the users in developing skills for dealing with the new technologies and in setting priorities. The user has a tendency to meet short-term needs at the expense of orderly long-term development. The information management group, on the other hand, can become preoccupied with mastering the technology and establishing a development plan at the expense of prompt response to the legitimate needs of the end-user.

Effectively balancing the roles of these two groups is a complicated chore for top-management; they must take into

account such factors as the sociological aspects of the organization, the potential impact of new technology, organizational structure, and geographical considerations.

The three disciplines: 1) data processing, 2) teleprocessing (communications), and 3) office automation have grown with very different management focus for historical reasons. There are three key reasons for merging these disciplines into a single Information Management organization:

1. Decisions in each area now involve large amounts of money and complex technical and cost evaluations.

2. The types of analytical skills and project management skills and staff needed to plan and implement applications are similar for each of the technologies.

3. Many systems call for the combination of these technologies into networks that handle computing, telecommunications, and office automation in an integrated way

A strategic information systems plan, in its broadest sense, is necessary for organizations to be competitive in the future. Top-management recognition of this requirement and their support is essential.

> Soon, there will be no such thing as a stand-alone computer system.
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> SPP '84'

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